TOTAL WATER ENVIRONMENT MANAGEMENT: A CONCEPT PLAN FOR DEVELOPING INTEGRATED WATER RESOURCES MANAGEMENT AT U.S. ARMY INSTALLATIONS

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Abstract. This paper describes the initial ideas for the Total Water Environment Management project of the U.S. Army Environmental Policy Institute, which is providing policy analysis and support for integrated water resources management for Army installations.

Because an Army installation is similar to a small county in water resources use and management requirements, but is simpler in political/administrative structure, it makes a good case subject for developing and testing software and procedures for integrated water resources management, which could later be adapted for local government.

INTRODUCTION

A.E.P.I. The U.S. Army Environmental Policy Institute (AEPI) was established in 1990 with the mission to assist the Army Secretariat in developing an Army environmental investment strategy. The new institute, which moved to the Georgia Tech campus in 1994, was initiated to help the Army develop proactive policies and procedures to address emerging problems and opportunities in water management, including: increasing legislation and regulations, increased population growth and demand on water resources, increasing public demands for complete cleanup, and need to demonstrate the Army's commitment to stewardship of natural and environmental resources, especially for the 12 million acres within Army base installations.

The Army's vision of stewardship is outlined in the *U.S. Army Environmental Strategy Into the 21st Century*: "The Army will be a national leader in environmental and natural resources stewardship for present and future generations as an integral part of our mission."

U.S. Army Installations. The U.S. Army manages nearly 12 million acres within its 112 installation sites (see Table 1). These military installations are used to meet the Army's mission by providing troop training areas and military industrial facilities. Land within these installations is used for "cantonment" areas (troop and family housing and service areas), training areas, impact areas and buffer areas. Water uses within the cantonment areas are similar to those for small cities.

Total Water Environment Management Project. The U.S. Army Environmental Policy Institute (AEPI) has initiated a project to support implementation of "total water environment management" at Army installations.

Total water environment management means that all decisions affecting the installation's water resources are made in a proactive and coordinated manner to best meet the multiple objectives of Army mission, environmental protection and cost containment. Decisions include both day-to-day operational and long range planning decisions affecting the installation's water use and supply, wastewater, stormwater drainage, flood hazard, and ecosystem health.

AEPI will develop policies and procedures to support comprehensive water resources management within the installations, and cooperatively with neighboring areas, to emphasize pollution prevention, water conservation and protection of water supply sources. Support materials will include an interactive software package containing the tools needed to streamline the installation-wide water resources planning and management, such as: integrated policy guidance, on-line procedural manuals, management information and decision support systems, automated compliance monitoring and reporting, expert systems for engineering design, training materials, and an overview simulation model of the installation's water environment and infrastructure.

The water management procedures will be designed to balance the installation's water needs, ensure compliance with environmental regulations, respect local water rights, enhance cooperation and communication, and show the Army to be a good citizen and a leader in environmental stewardship, to to accomplish the vision outlined in the *U.S. Army Environmental Strategy Into the 21st Century.*

Professional Contribution. The project's contribution to the field of water resources planning and management will be as follows. (1) The project's concept plan will provide a blueprint for efforts to implement integrated water management within a defined jurisdiction. It will serve as a checklist of what is actually needed to bring about integrated water resources management. (2) The project will provide a complete, integrated set of information management and analysis tools to support comprehensive water management within a defined jurisdiction. (3) With some adaptation to cover the more complex case of multi-jurisdictional water management, the concept plan and tools developed here could be useful for local and state governments in the future. (4) The information management and analysis tools developed here will be evaluated for effectiveness before being recommended for widespread use.

An Army installation provides a more tractable case (as compared with a municipality) for testing and refining the information and organizational management approaches to best achieve integrated water resources management.

ARMY INSTALLATIONS

Water Uses

Army installations, which provide housing and service facilities for troops and military families, are similar to small cities in their water and wastewater uses and in their obligation to comply with environmental regulations. Typical installation activities using water supply and/or wastewater services include (1) housing: family housing, barracks, officers quarters, mess halls; (2) commercial: commissary, hospitals, post exchange, instruction facilities, gas stations, laundromats, cafeterias, post office, bank; (3) industrial: vehicle and aircraft washracks, steam cleaning, metal plating and finish, autoclaves, boilers, metal cleaning, paint bath water wall, air pollution wet scrubbers, laboratories, cooling towers, dynamometers, engine test cells, ash handling systems, pesticide management, photographic laboratory, motor pools; (4) recreational: swimming pools; and (5) irrigation: parade grounds, athletic fields, golf courses, cemeteries, lawns, parks and commercial landscaping. In 1983, irrigation consumed more than 50% of some installations' summer water use, while family housing represented 18 to 70% of annual use (Bandy and Scholze, 1983; in Uber, 1994).

Like civilian communities, the installation cantonment areas have infrastructure for stormwater collection, storage and treatment and must manage stormwater runoff and non-point source pollution. "Grounds maintenance activities and agricultural practices often use fertilizers and pesticides. Materials storage areas, for example underground storage tanks, are also a potential pollutant source" (Uber, 1994).

Unique Features of Installations' Water Use. Army installations do differ from a typical municipality in some respects. The water use varies due to population fluctuations when civilian employees leave in the evenings and when military employees leave enmass on military maneuvers, training exercises and holiday leave passes. Water use is often not metered, and army personnel pay fixed fees for unlimited water (Brady 1983, in Uber 1994).

Military industrial facilities usually operate at less than one-half capacity during peacetime (Uber 1994).

Unique Features of Installations' Water Impacts. Large land areas are used for military training exercises which may cause nonpoint source pollution. Tank maneuvers, parachute drops and mobilization, engineer training, stream crossings, and artillery practice may all cause erosion or release of chemicals (Goran et al, 1988; in Genskow 1994). Land areas with unacceptable erosion may be as high as 35% of an installation's training land. Land and water areas may be affected when "training chemicals are released during weapons firing and the use of smokes and other obscurant" (Uber 1994).

Table 1. Land Use for Military Installations

Land Use Category	Acres
In United States:	
FORSCOM (19)	2,959,000
TRADOC (15 sites)	1,975,000
AMC (33 sites)	4,393,000
NGB (30 sites)	787,000
USARPAC (15 sites)	1,817,000
Total in U.S.	11,931,000
Example Land Use Distribution (for Fort Riley, Kansas):	
Cantonment	8,687
Training	55,931
Impact Area	5,213
Impact Buffer	11,158
Multi-purpose Range	6,844
Surface Water	3,534
Use Restricted	10,845

INTEGRATED DECISION MAKING

Comprehensive Water-Environment Simulation Model. A centerpiece of the project will be a comprehensive simulation model of the installation's water environment and infrastructure to serve two purposes: (1) to provide the Installation Commander with an overview of the water/environment system's status at any time and (2) to allow the unit managers responsible for water supply, wastewater, water using activities, and land management to simulate the effects of their proposed decisions on the overall system. The latter will support coordinated decision-making and help individual managers avoid actions that are not best for the overall Installation goals (ie., avoid globally suboptimum actions).

The model will consist of several "layers" which represent the key components of any regional water management system (civilian regions as well as Army installations):

- a physical layer to represent water and material flows within the region and across region boundaries;
- water use and infrastructure layer to represent demands on the physical system and facility capacities to serve those demands;
- planning layer to represent present and desired system state, decision alternatives and costs;
- management/personnel layer to represent the system operation and decision-making capabilities;
- monitoring and compliance layer to track the system's performance;
- research and policy layer to identify information gaps and to trigger decisions regarding future goals and directions.

These layers will be represented as interlinked models within the overall system model.

Water and Materials Flow Layer. This layer consists of a simulation model to track significant water and material flows into an Army installation, through the natural hydrologic and manmade conduits within the installation, and then to storage or exit from the installation.

Inflows are considered from both natural sources (rainfall, stream and aquifer flows) and human sources (materials purchases, materials importation). Water and materials movement and use within the installation will be simulated using linked submodules to represent key processes of: rainfall runoff and infiltration, stormwater runoff and detention, streamflow and quality, reservoir storage and quality, groundwater flow and quality, wetlands interactions with surface and groundwater, water withdrawal and treatment facilities, offstream water uses (residential, cantonment, manufacture), materials processing/reuse/disposal (cantonment, manufacture), wastewater collection and reuse, wastewater treatment and disposal.

Unit Processes and Infrastructure Layer. This layer includes simulation modules of specific processes to simulate their present and future water use and waste generation. It is used to help identify alternatives for water conservation, pollution prevention and materials reuse.

Decision and Planning Layer. This layer contains a complete listing of short and long-term decision occasions, and the alternatives available at each decision point. (The decision points are identified by evaluating the "water and materials flow" layer.) It also contains planning-level information on the alternatives, such as infrastructure capacity and condition; estimated unit costs to repair, upgrade, expand or construct any infrastructure component.

It will provide a template and expert system for preparing the five-year Installation Master Plan, to serve as a framework for related functional plans in these areas:

- Transportation Plan
- Installation Hazardous Waste Management Plan
- Spill Prevention Control and Countermeasures Plan
- Installation Spill Contingency Plan
- General Water System Plan
- General Sanitation Sewer System Plan
- General Storm Drainage Plan
- Utility System Analysis Expansion Capability Plans
- Master Planning and Construction Programming Plan
- Historic Preservation Plan
- Training Area\Ecological Management Plan

Management Layer. This layer contains information regarding the people responsible for operating the system, and their capacities. For each decision point, it lists the name of the responsible operator, operator's supervisor, operator's skills and training, available resources and decision aids, performance criteria, and incentive structure.

Monitoring and Compliance Layer. This layer contains the performance data for the system, including the units of measure for indicating the system's state in terms of each objective (mission, environment, budget). For example, key performance measures to indicate the environmental state might be: tons of erosion per year, number days when installation was not in compliance with certain EPA water quality standards, increase in potential annual stormwater runoff, change in acres of habitat for species assemblage A, percent depletion of groundwater storage, etc. Selecting the best set of system state indicator variables is an important part of this project.

Through interaction with this layer on their desk computers, unit managers will enter routine monitoring data and then will receive immediate on-screen summary reports regarding their unit process's present performance as compared to standards, short-term performance trends, notices of any projected adverse trends and suggestions for corrections, and estimated effects on other units.

This module will have the capability to automatically generate the performance reports required by various environmental statutes and in the format of the regulating agency. It will also generate a monthly report to the Installation Commander, giving an overview of the system's status and performance over the last month, flagging any areas needing immediate attention, and highlighting any outstanding accomplishments and personnel deserving recognition.

Research and Policy Layer. This module will compare the system's predicted performance with actual monitoring data as it is entered, and will generate a report showing where predictions are inaccurate -- to indicate where additional research may be needed.

CONCEPTUAL APPROACH

Integrated water resources management is accomplished by making all water-related decisions in a coordinated manner that recognizes the interrelated nature of the water resources system. Therefore, the approach will be to focus on the decision-making processes of Installation water managers, and to provide them with the understanding, tools and incentives to practice integrated water resources management.

The method is to identify all decisions (both daily operational decisions and long-range structural decisions) and to provide sufficient policy guidance, information and support so that, at each decision event, the option most compatible with the principles of integrated water resources management is identified, selected and effectively implemented.

Decision Making Process

The human decision-making process may be divided (Simon, 1960) into three phases:

- *Intelligence:* searching for conditions that call for decisions.
- *Design:* inventing, developing, and analyzing possible courses of action.
- *Choice:* selecting a course of action from those available.

The TWEM project will focus on enabling the water managers in all departments to improve their decision-making capabilities and outcomes at each phase.

The following ideas for subprojects within the Total Water Environment Management project will be considered, to support effective decision-making in several ways:

1) Computer software and on-line procedural manuals to be developed as aids for each phase (intelligence, design, choice) and for each water area (water supply, wastewater, stormwater, land use, etc.) Existing manuals will be reviewed and revised to support TWEM principles.
2) Educational materials will be identified (or recommended for development) for each decision phase and water department.
3) A prototype management information system (MIS) to be developed to provide comprehensive information and coordinate decisions across all departments. The existing MIS will be reviewed and updated.
4) The organizational structure and management policies for a typical installation will be analyzed for consistency with effective decision-making at each phase, consistent with TWEM principles, and an ideal arrangement will be outlined.
5) An strategy for effectively introducing and implementing TWEM at an Army installation will be outlined (ie., steps for converting an installation to TWEM).
6) The materials and procedures developed via TWEM project will be tested for effectiveness, where possible.
7) AEPI will identify and research policy options for some key decisions. AEPI will identify technical research topics to address areas where existing knowledge is insufficient to support the TWEM project.

Symposium on Total Water Environment Management

A symposium is being organized for September 1995 to bring together experts on the various components of the Total Water Environment Management project. The symposium participants will provide peer review of the project's concept plan and will present papers discussing the project components.

LITERATURE CITED

Bandy, J.T. and R.J. Scholze, Distribution of Water Use at Representative Fixed Army Installations, U.S. Army Construction Engineering Research Laboratory, TR N-157, August 1983.

Genskow, K.D., 1994, "Surface and Groundwater Management at Army Installations: Analysis and Recommendations," prepared for U.S. Army Environmental Policy Institute, 29 August 1994, 12 pages.

Simon, H. *The New Science of Management Decision.* New York: Harper and Row, 1960.

Temkar, Prakash; James Uber, Ken Genskow, Robert Riggins, Kathryn Hatcher, and Ben Yen, "New Directions in Water Resources Policy Science," prepared for U.S Army Environmental Policy Institute, December 1994 (draft), 16 pages.

Hatcher, Kathryn J., "Contributions to the Concept Paper for the TWEM Project Design," prepared for the U.S. Army Environmental Policy Institute, October 1994 (draft), xx pages.

U.S. Army Environmental Strategy Into the 21st Century